COASTAL AEROSOL DISTRIBUTION BY DATA ASSIMILATION
PE 0602435 (NRL BE-035-32-23)

Dr. Douglas Westphal
Naval Research Laboratory
Monterey, CA 93943-5502
(408) 656-4743, (408) 656-4769 (FAX)
westphal@nrlmry.navy.mil

LONG-TERM GOALS:

The long-term goal of this research is to develop an initialization scheme for a multi-dimensional, predictive aerosol model in coastal regions. The initialization scheme will include data gathering, quality control and data assimilation of the available aerosol observations, including satellite radiances, ground-based remote sensing, point measurements, and the previous aerosol forecast.

OBJECTIVES:

The objectives of this program are to (1) investigate and evaluate the existing and proposed aerosol retrievals from satellites for applicability to aerosol model initialization and (2) develop and test aerosol analysis and data assimilation techniques using satellite and other aerosol measurements.

APPROACH:

The approach to the problem of aerosol and EO extinction prediction follows that used in numerical weather prediction, namely real-time assessment and first-principle modeling. The predictive model requires the initial spatial distribution of the aerosol field. Sensors and retrieval techniques exist for obtaining the aerosol optical depth and some information about particle size. The remotely sensed aerosol properties typically are vertical integrals and are generated at horizontal resolutions ranging from 1-km to 1-degree. An objective analysis method will be devised to merge the 2-D distribution from remote sensing with point measurements and model constraints to produce a three-dimensional description of aerosol. Satellite datasets for the period of the Gulf War will be gathered and used to test the analysis and assimilation techniques.

WORK COMPLETED:

		Form Approved OMB No. 0704-0188
	Report Documentation Page	*Form Approved* *OMB No. 0704-0188*

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1. REPORT DATE **30 SEP 1997**	2. REPORT TYPE	3. DATES COVERED **00-00-1997 to 00-00-1997**
4. TITLE AND SUBTITLE **Coastal Aerosol Distribution by Data Assimilation PE 0602435 (NRL BE-035-32-23)**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Research Laboratory,Monterey,CA,93943-5502**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **Same as Report (SAR)**	18. NUMBER OF PAGES **3**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Programs to retrieve aerosol optical depth from AVHRR and GOES satellite data have been ported to NRL/MRY from NPS and are being implemented. Current TOMS satellite data are being obtained and analyzed at NRL/MRY. The historical AVHRR and TOMS data for Desert Storm have been obtained and are being analyzed and compared. Aerosol products from future sensors, particularly those on NASA's EOS platforms, have been investigated.

A global aerosol model has been implemented at NRL/MRY. This model will be used for spatial and temporal continuity between successive satellite overpasses. It is driven by NOGAPS meteorology and uses emission inventories for specifying the source of aerosol. It has been run for the period of Tropospheric Aerosol Radiative Forcing Experiment (TARFOX) in July 1996. Preliminary verification has been done. Programs for visualizing the global, multi-component, multidimensional data have been developed.

RESULTS:

The differing resolutions of the TOMS (1-degree) and AVHRR (1- or 4-km) data pose a problem to combining the two datasets through data assimilation. Despite its coarse resolution and lack of calibration, the TOMS data are valuable since they yield information over land while the high-resolution AVHRR data yield data only over the ocean. The satellite products from future sensors on NASA's EOS platforms will include much more detailed information on aerosol composition and size distribution and will be useful in validation of models. However, the coverage may be insufficient or too infrequent for practical use in data assimilation.

The global aerosol model has produced credible sulfate aerosol distributions, though validation is problematic in most regions of the world due to the low aerosol optical depths that go unnoticed by satellite retrievals. Including other aerosols, such as smoke or dust, will allow more extensive validation of transport since these aerosol are often more easily observed by satellite.

Figure 1. Satellite data for March 10, 1991. Left panel: AVHRR visible wavelength data at 4-km resolution showing detailed features of Saudi Arabian Peninsula and Persian Gulf. A thin plume of smoke can just be seen emanating Kuwait and flowing southeastward. Right panel: TOMS data for same time and location but at lower resolution. However, the data reveal an extensive cloud of absorbing aerosol (smoke) over much of the Arabian Peninsula.

IMPACT:

This research provides tools for the 6.1 and 6.2 aerosol research communities and the academic community. Because of the difficulty and expense of in situ measurements, the satellite retrievals are essential to fundamental research into all aerosol systems, except at the smallest scales.

TRANSITIONS:

In the long term, the results from this research will allow the Navy to fulfill its goal of a predictive capability for aerosols and EO propagation. In the near future, the analysis and retrieval techniques will provide real-time aerosol products showing the distribution of smoke, dust, volcanic ash and other aerosols that can be dissemination to the fleet for use in tactical, strategic and defense planning and used in EOTDA validation and development.

RELATED PROJECTS:

The NRL 6.1 Coastal Aerosol Processes ARI and NRL 6.2 Weather On Target use the satellite retrievals for validation, even though the data assimilation technique has not yet been developed and three-dimensional distributions are not yet available. The two-dimensional retrievals show location and movement of aerosol clouds. This work is also relevant to two 6.4 efforts in EOTDA evaluation and aerosol measurement.

Gulf War Illness studies have used the satellite retrievals to monitor transport in the Gulf region. The retrievals clearly show the smoke from the Kuwaiti oil fire plumes. The inferred dispersion rates and transport speeds have been used to validate chem-bio models.

REFERENCES:

None.

PATENTS:

None.